

PICTURE OF THE MONTH

Satellite View of a Lake-Effect Snowstorm

EDWARD W. FERGUSON

Applications Group, National Environmental Satellite Service, NOAA, Suitland, Md.

The lake effect on snowfall has been of great interest to meteorologists for many years. Earlier work by Sheridan (1941) and Wiggin (1950) showed that cold arctic air flowing across relatively warm open water such as Lakes Erie and Ontario picks up vast amounts of moisture and heat. This is most pronounced during the early winter months when there is a large air-lake temperature difference. Heating of the lowest layer of arctic air produces convection that can result in heavy snowfall to the lee of the lakes.

Later, a group of scientists under the direction of Dr. George McVehil made a study (McVehil et al. 1967) on the lake effect and agreed with these earlier ideas, but further concluded that initial air mass stability, height, and strength of air inversions and large-scale vorticity are important factors in determining the extent of lake-induced snow.

Lavoie (1968) tested several of these ideas in his model of mesoscale lake-effect storms, found good agreement with earlier results, and observed that the most intense band of convergence was created when the average wind direction below 850 mb was 250° – 280° with little shear but with large vertical gradient. He did, however, have difficulty explaining the strong vertical motions associated with the most severe storms of this type.

Justo et al. (1970) made an extensive investigation of this type of snowstorm, with strong emphasis on determining what mechanism controlled the intensity and amount of snowfall to the lee of lakes. Conclusions drawn from this study supported earlier work, but added at least one important new idea. Justo found that a severe snowstorm occurred when there was an upper level shortwave trough located west of the heavy snow area. This shortwave trough was so positioned that there was positive vorticity advection (on an isentropic surface) east of the trough over the lake area where other criteria had been met and conditions were ripe for heavy snowfall.

The satellite pictures in figures 1A and 1B show the band of clouds, (A) to (B), associated with a severe snowstorm to the lee of Lake Erie on Nov. 23, 1970. The cloud band appears to form near the central portion of the lake. The winds were moderately strong from the west-southwest as cold arctic air moved across the relatively warm lake. A rapidly moving front passed Buffalo, N.Y., during the evening of November 22 and was located just off the east coast (fig. 2) by the time the satellite picture was taken at 0941 EST on November 23. The clouds associated with a portion of this front extend northeast from point (C) in figure 1A. At 0700 EST on November 23, the National Meteorological Center (NMC) vorticity analysis (fig. 3) showed an upper level trough

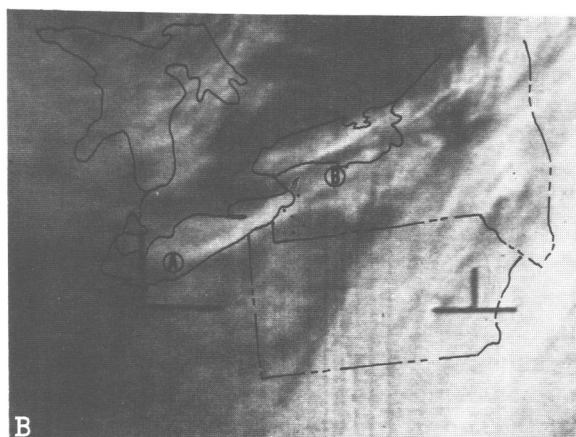
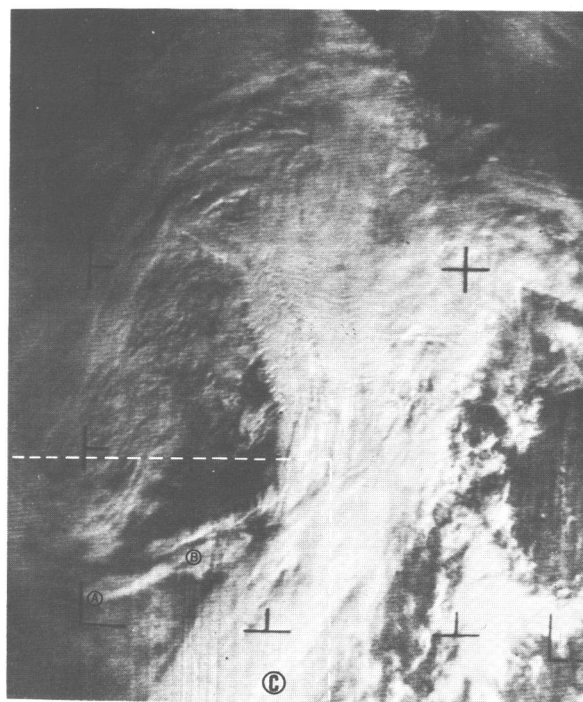


FIGURE 1.—(A) ESSA 8 APT photograph at 0941 EST on Nov. 23, 1970; (B) an enlargement of the area enclosed by the dashed line in (A).

over Lake Michigan with positive vorticity advection (on a constant pressure surface) extending from just east of the trough northeastward across Lake Erie. These conditions meet many of the aforementioned requirements for a severe lake-induced snowstorm. The following is an account of the weather produced in this situation.

As west-southwesterly winds swept across Lake Erie behind the front, snow began falling during the night of November 22 on the downwind shores of the lake; and

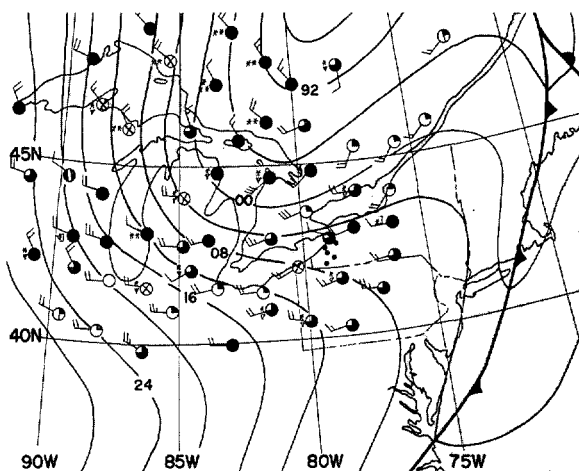


FIGURE 2.—NMC surface analysis with surface winds, present weather, and sky condition plotted for selected stations at 1000 EST on Nov. 23, 1970; the dots in the southwestern part of New York State correspond to the location of cities indicated in figure 4.

by 0800 EST on November 23, East Aurora, N.Y., reported 18 in. of new snow. It is interesting to note that, although Buffalo is only about 10 mi northwest of East Aurora, only a trace of snow had fallen by this time. At 0942 EST, the Buffalo radar (fig. 4) showed an area of echoes about 30 mi wide and 150 mi long from near Rochester, N.Y., to Erie, Pa., with a small line 10 mi wide and 70 mi long of stronger echoes (12-dB return) inside the larger area. Radar indicated the tops of the stronger echoes to be at 14,000 ft. Notice that East Aurora is near the center of the stronger echoes while Buffalo is just north of it. The stronger area of echoes corresponds to the brighter portion of the band of clouds, Ⓐ to Ⓑ, in figures 1A and 1B.

The surface trough moved southeastward during the day and was located over eastern Lake Huron by midafternoon. This produced a westerly flow across Lake Erie; and with this change in wind direction, there came a corresponding southward shift of the heavy snow area. By 1500 EST, 8–9 in. of new snow had fallen as far south as Boston, N.Y. East Aurora had accumulated an additional 6 in. of snow while Little Valley had received a trace at this time. Some places in western New York were paralyzed by the storm; and at 1600 EST, the town of Evans, under 24 in. of snow, declared a state of emergency due to the adverse weather conditions.

During the evening as the surface Low and upper level vorticity center moved east, the low-level flow became more perpendicular to Lake Erie. By 0800 EST on November 24, the storm had subsided, but not before it had covered the area as far south as Jamestown, N.Y., with 8–10 in. of snow during the night.

In this example of a lake-induced snowstorm, the satellite picture shows the clouds associated with the storm. In areas where the proper conditions exist for the development of a storm of this type and where there is inadequate radar coverage, the satellite data would be most helpful in defining the probable area of heaviest snowfall.

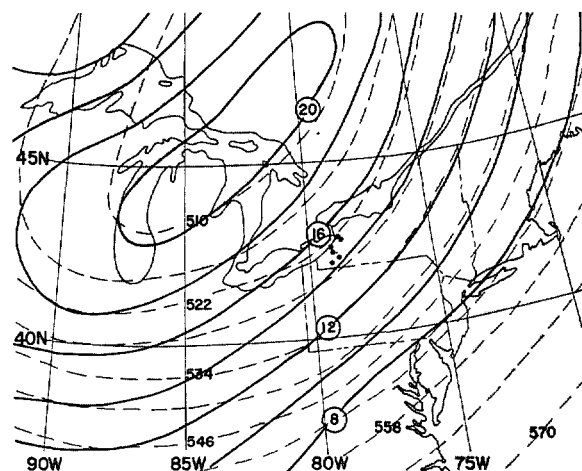


FIGURE 3.—NMC vorticity (solid lines) and 500-mb (dashed lines) analyses for 0700 EST on Nov. 23, 1970.

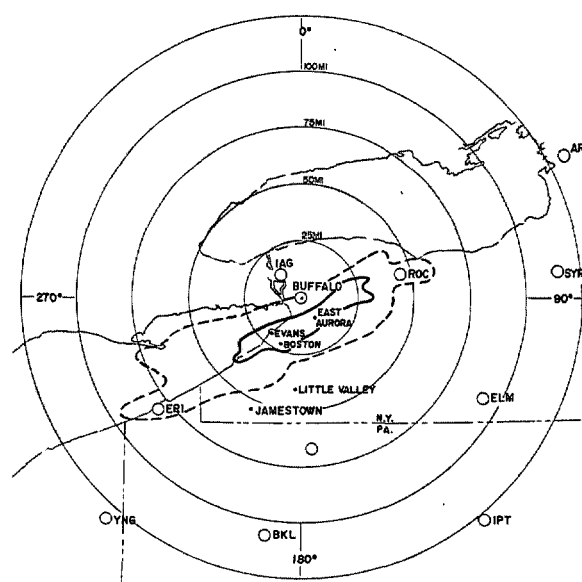


FIGURE 4.—Precipitation area as shown by the Buffalo, N.Y., radar at 0942 EST on Nov. 23, 1970.

ACKNOWLEDGMENT

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